that we are confronted with questions about distances, angles, and so on. We are bound to interpret the distance ($\delta$) between the points ($a+bi$, $c+di$) and ($a'+b'i$, $c'+d'i$) as given by

$$\delta^2=\{(a-a')+(b-b')i\}^2+\{(c-c')+(d-d')i\}^2,$$

and there are corresponding theorems about angles.

On the whole, we think Prof. Hatton's book will be most useful in suggesting ways in which the Cartesian way of regarding complex points (and lines) is brought into line (without sacrificing logic) with the projective theory. What we may call the complex point (OP), meaning the involution (with a definite sense) of which O is the centre, and $-\mathrm{OP}^2$ the invariant ($\mathrm{OQ}.\mathrm{OQ}'=-\mathrm{OP}^2$), is a perfectly definite idea, and is a special case of von Staudt's representation of any complex point in the harmonic form ($\mathrm{O}\infty\mathrm{PP}'$) or ($\mathrm{O}\infty\mathrm{P}'\mathrm{P}$) with the initial point O.

Von Staudt's theory is purely projective, apart from the discussion of improper casts. The Cartesian theory is bound to deal with metrical quantities, such as distance and angle, and simply because these notions are derivative, it offers a field of research of a more complicated character. It may be asserted with some confidence that any real extension of von Staudt's theory will be of a metrical kind, and that, if it is worth anything, it will be applicable to three dimensions (or more) as well as to two. G. B. MATHEWS.

P.S.—Since the above was written, I have had time to reflect further upon Prof. Hatton's book, and have read Prof. G. H. Hardy's review of it in a recent number of the *Mathematical Gazette*. I do not wholly agree with Prof. Hardy's attitude, because I still think that there are geometrical notions not reducible to arithmetic—still less to formal logic. But I do agree with him that Prof. Hatton's book has no theoretical value, and, disagreeable as it is, I think it is my duty to say so, especially as I have been informed that another reviewer has praised the book in absurdly exaggerated terms. G. B. M.

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## Motion Study and the Manual Worker.

*Motion Study for the Handicapped.* By Frank B. Gilbreth and Dr. Lillian Moller Gilbreth. (Efficiency Books.) Pp. xvi+165. (London: George Routledge and Sons, Ltd., 1920.) Price 8*s*. 6*d*. net.

THE work of Mr. Frank B. Gilbreth upon applied motion study and fatigue study is well known, and the present volume describes various extensions and additions to his previously recorded methods, especially with the intention of assisting men who are handicapped by the loss of a limb or of their eyesight. In Mr. Gilbreth's latest scheme the manual worker whose movements are being studied has a small electric light attached to the hand or other working member of the body, and thereby the path of the motions made can be determined in detail if a series of photographs is taken by kinematograph. Other photographs are taken with a stereoscopic camera, and by this means the path of the motion in three dimensions is ascertained. It is then possible to construct wire models showing exactly the path of a given motion, and such models are found to be very useful for instruction purposes. Series of models are exhibited at the Smithsonian Institution, Washington, and elsewhere, so that skilled mechanics are able to see for themselves what are considered to be the best methods of performing certain motions, and to determine if they themselves fall short of the ideal.

Again, Mr. Gilbreth represents on diagrams, termed "simultaneous-motion cycle charts," the results of his studies on micro-motion. Such charts, when read downwards, present in chronological sequence the various activities performed by any member of the body, the posture taken during the action, and the time consumed. If read across, the charts give a record of all the working members of the body at any one time, and they enable one to see which parts of the body are working most and which are being delayed. It is maintained that this chart system enables the workmen to visualise their efforts graphically, and thereby to lessen waste and increase efficiency.

The great ingenuity of Mr. Gilbreth's methods will be admitted by everyone, but it is more important for us to determine their practical value. Mr. Gilbreth photographs champions playing baseball, champion typists, skilled surgeons when operating, in addition to skilled tradesmen, and he believes that the skill shown is in every case based on one common set of fundamental principles, the principles of economy of effort and rhythm of motion. The application of this hypothesis to practical ends is, however, very far distant. The concrete instances quoted. of the employment of micro-motion study in actual practice are very few and not very striking, but doubtless it will take a good deal of time before they can be adequately tested and applied.

The portion of the book devoted specially to the handicapped describes several useful methods, though it strikes the uninitiated that they could have been evolved equally well without elaborate micro-motion study and motion-cycle charts. The one-armed typist is supplied with a typewriter

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which has a magazine of paper lasting him a week, and he is enabled to type four copies at once by means of ribbons instead of carbon paper. The blind man is trained by visualisation, and is taught to use a cross-sectioned visualising board, on which the tools and equipment he is using are placed at fixed points. Thereby great waste of time and effort is saved. The importance of finding work that cripples can do, and of teaching them to do the work, is insisted on. Not only have the war cripples to be considered, but also the very numerous workers crippled as the result of industrial accidents.

H. M. V.

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## Our Bookshelf.

*Engrais. Amendements Produits anticryptogamiques et Insecticides.* Par Dr. E. Demoussy. Pp. xi+297. Paris and Liége: Ch. Béranger, 1919. Price 15 francs.

DR. DEMOUSSY's manual on the analysis of fertilisers is written for the trained chemist; it is founded on the methods laid down in 1897 by the Comité des stations agronomiques, but unofficial methods in use in the principal French laboratories are also described. After a short introduction on the laws regulating the sale of fertilisers, the author deals in the first two chapters with the collection of samples and their qualitative examination. The following four chapters treat of the determination of nitrogen, phosphoric acid, potash, and manganese, the arrangement being according to the substance to be determined, and not the material in which it is found. The methods are for the most part well known in this country, and call for only a few remarks. The longest section is that devoted to nitrogen. The official method for nitrates is that of Schloesing, and no mention is made of the zinc-copper couple, while for organic nitrogen the Kjeldahl and soda-lime processes are both recommended. The latter has fallen into almost complete disuse in this country, and probably few chemists here would agree with the opinion that it is the more economical in time when many samples are to be examined. Where a purely chemical analysis would be of little value, as in the case of dried blood, drawings of the materials as seen under the microscope are given. The value of these would have been greatly increased if the magnification had been stated. Under the head of potash no reference is made to flue-dust; in this case the official methods would have to be slightly modified to ensure complete removal of silicic acid.

The second and third parts of the book deal with materials such as lime and with fungicides and insecticides. Tables for the calculation of results are added, and the appendix contains the French laws and regulations dealing with the sale of fertilisers.

The book is well arranged and clearly written, and its value is added to by notes on the form in which the various materials are put upon the market and the adulterations to which they are liable. It should prove very useful in analytical laboratories in this country as well as in France.

DONALD J. MATTHEWS.

*Flora of Jamaica: Containing Descriptions of the Flowering Plants known from the Island.* By William Fawcett and Dr. Alfred Barton Rendle. Vol. iv., *Dicotyledons: Families Leguminosae to Callitrichaceae.* Pp. xv+369. (London: British Museum (Natural History), 1920.) Price 25*s.*

THE fourth volume of this admirable tropical flora has lately appeared, and contains the Dicotyledons from Leguminosæ to Callitrichaceæ (on the Englerian system). It maintains the high standard of its predecessors, and shows a great advance upon some well-known tropical floras in being illustrated by excellent text figures, and not by a series of separate plates, which are usually troublesome to consult. The index is also convenient in being only a single list of both scientific and popular names and synonyms. Turning to the contents of the book, which have been worked up with much care and after consultation of all the older authors and collections, an interesting feature that may be noticed is the extraordinary generic similarity of the flora to that of other islands, even at immense distances from Jamaica. In the Leguminosæ, for example, the first family in the volume, 118 Jamaica species, or 80 per cent., belong to genera that also occur in Ceylon, 74 per cent. to genera occurring in Formosa, and even in the case of so far distant an island as New Caledonia 63 per cent. of the Jamaica species belong to common genera. It is clear that the islands on the whole contain the older genera, which have been able to reach them. Of the Jamaica genera of Leguminosæ 70 per cent. are cosmotropical, and only 14 per cent. are confined to the New World. Again, one notices that the proportion of endemic species is small in Leguminosæ, and larger in Euphorbiaceæ and some of the other families, just as in other floras. It would appear a promising piece of work to make a careful statistical study of numbers and proportions of endemics in many countries, for it evidently follows definite, if perhaps recondite, laws.

*Butter and Cheese.* By C. W. Walker Tisdale and Jean Jones. (Pitman's Common Commodities and Industries.) Pp. ix+142. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2*s.* 6*d.* net.

THE writers of this book have succeeded in giving to the general reader a very good account of the essential facts in connection with the dairying industry. As was to be expected, it was necessary to treat the subject on what are generally termed popular lines, but certain of the chapters are written in a particularly clear manner and with full regard to the essential technical points. Not only the chief branches of the dairy industry—cheese-making and butter-making—are dealt with, but also the production of milk, the methods of analysis, and the judging of dairy produce are

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